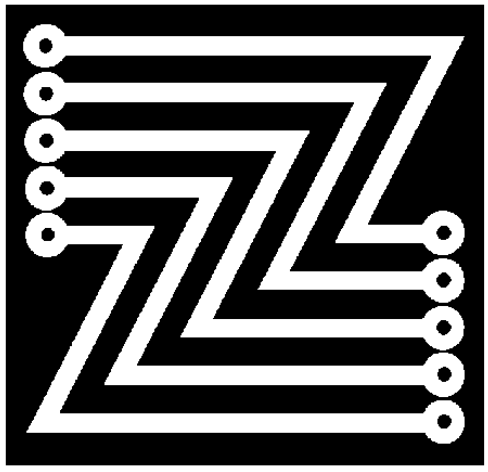
Sine Saver

User's Manual



ZENER TECHNOLOGY AND QUALITY ASSURANCE

Since 1978 Zener Electric has supplied many thousands of AC drives to industry. These drives have been installed into numerous applications resulting in a wealth of in house experience. The Zener SINE SAVER controller is the culmination of this experience, modern technology and industrial application requirements. The Zener Quality Assurance program ensures that every SINE SAVER manufactured has proven to operate correctly in the production test bay before dispatch.

SINE SAVER PRODUCT WARRANTY

Zener Electric warrants SINE SAVER against defective workmanship and materials for a period of 12 months from the date of dispatch. Such defects will be rectified free of charge for both labour and material, at Zener Electric's premises subject to:

1. Zener Electric's customer raising an order upon Zener for service and/or repairs, subject to a warranty claim. The order is to state particulars of the model and serial number, the date of original purchase and invoice/delivery docket number.
2. All damage resulting from incorrect installation or use other than in accordance with the instruction manuals issued by Zener Electric is excluded from this warranty.
3. The Warranty being rendered invalid if the product is misused or if any unauthorised alteration, modification or substitution of any part of the product be made or the serial number of the product is defaced or altered.
4. The cost of transportation (both ways) is to be met by the owner if it's necessary to return the product, or any part of it, to Zener Electric's premises.
5. A charge being accepted by the owner for traveling time and expenses incurred in connection with warranty service at the user's site as requested by the owner.
6. If the product was not purchased from Zener Electric directly, then a warranty claim must be lodged with the original supplier in the first instance. Repairs will not be effected by Zener Electric unless approved by the original supplier. Goods not of our own manufacture incorporated in our supply or sold by us, carry their maker's warranty only.
7. Goods returned for claim under warranty will be accepted on the condition that should the claim be rejected then all costs, including inspection, will be charged to the customer's account.
8. Zener Electric is not liable for any consequential loss.

SAFETY

Your SINE SAVER must be applied, installed and operated in a safe manner. It is the responsibility of the system builder and user to ensure compliance with all regulations and practices covering the installation and wiring of your SINE SAVER. The instruction manual should be completely read and understood before attempting to connect or operate SINE SAVER. Only skilled personnel should install this equipment.

This equipment contains a number of components that are designated by their various manufacturers as "*not for use in life support appliances, devices, or systems where malfunction of the components can reasonably be expected to result in personal injury or death*". Customers using or selling Zener products for use in such applications do so at their own risk and agree to indemnify Zener for any damage resulting from improper use or sale.

THE CONTENT OF THIS MANUAL IS SUBJECT TO CHANGE WITHOUT NOTICE

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Warning

SINE SAVER must be applied, installed and operated in a safe manner in accordance with all local rules and regulations. In particular, it is the system builder's responsibility to address electrical safety, machinery safety and electromagnetic compatibility issues. The system may also contain high energy circuits that may be hazardous.

A typical SINE SAVER system will include capacitors that take greater than one minute to discharge below 50Vdc. Ensure that all power sources are isolated and all capacitors discharged to a safe voltage before working on any part of a the system.

Receiving

Inspect SINE SAVER for any shipping damage. If any damage is found, report it to the carrier immediately. Access the inside of the controller and visually check for any damage.

Do not attempt to operate SINE SAVER if any damage is apparent.

After the initial inspection, SINE SAVER can be repacked and stored in a clean, dry location until it is required for use. DO NOT store this equipment in an area where the ambient temperature will fall below -20°C (-4°F) or rise above 70°C (158°F). DO NOT store this equipment in areas of high condensation or corrosive atmosphere. Proper storage is necessary to ensure satisfactory controller start up and performance.

Software

This manual applies to SINE SAVER software revision 1.02. The software revision is displayed briefly at power up.

Introduction

SINE SAVER is a regenerative converter (active rectifier). Sine Saver may be used alone as a high quality reactive power compensator or in conjunction with other equipment to transfer power between AC and DC systems in both directions, at any desired power factor on the AC side. The AC side line currents are near perfect sine waves.

Applications

Typical Sine Saver applications include:

Ultra low harmonic rectifier for AC motor inverters or similar equipment

Line side converter for 4Q AC motor inverters

Alternative energy systems

Energy recovery from DC systems (eg railways)

Reactive power compensation - power factor COS(Ø) correction

Line voltage stabilization for weak distribution lines (eg rural areas)

Operating modes

In order to accommodate a wide range of applications, Sine Saver can be programmed to achieve the following :

DC link voltage regulator (AC line ←, → DC link)

Ultra low harmonic rectifier for AC motor inverters or similar equipment

4Q AC motor control inverters for elevators, hoists, high inertia industrial applications (centrifuge etc)

Reactive power compensator (AC line)

Reactive power compensator - power factor COS(Ø) correction

AC line voltage regulation - can be used to stabilise the voltage of weak electricity distribution lines in rural areas at a much lower cost and better performance than re-building the distribution line.

Energy recovery converter (DC link → AC line)

Alternative energy systems

Energy recovery from DC systems (railways)

Applications with multiple AC motor drives on a common DC link

Surplus capacity can be used for power factor correction in any mode

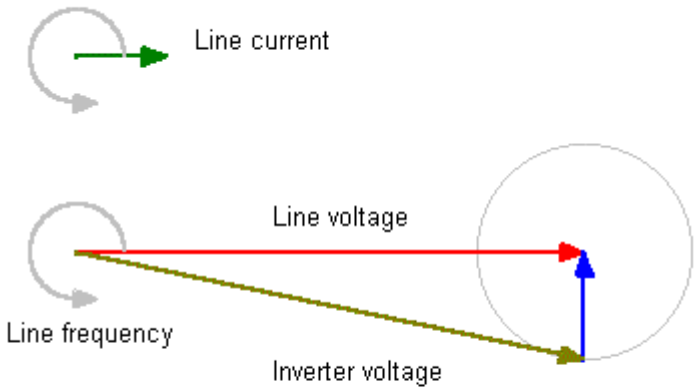
Note: Regulation of the DC link voltage is an essential part of all operating modes and is always active.

Principle of Operation

How does SineSaver work?

Fundamentally, **SineSaver** is a solid state inverter that generates an AC voltage from a DC source using pulse width modulation (PWM) techniques.

The AC line connection to **SineSaver** is always 3 phase. This line voltage can be represented as a voltage vector, meaning that it has both a magnitude and an angle. The concept of a magnitude is clear enough, but what about the angle? The simplest approach to this is to say "we have no control over the line voltage, so we will just consider it to be zero degrees and measure everything else relative to this". In the diagram below, the line voltage is represented by the horizontal line (angle = 0°), marked as *Line voltage*.



Now, the line voltage vector is really rotating at line frequency, that is, it goes through a complete 360° rotation either 50 or 60 times per second, depending on the local line frequency. Drawing the line voltage vector as a stationary line is convenient and can, if necessary, be shown to be appropriate in mathematical terms.

In the diagram above, the inverter output voltage, *inverter voltage*, is also a 3 phase voltage, advanced in phase (by around 20°) relative to the line voltage vector, V line. You can see that it has a slightly larger magnitude (the line is longer) as well.

In a **SineSaver** system, there is an inductor connected between the line voltage and the inverter output voltage. This is the line reactor. In the diagram, the voltage across the line inductor is simply the difference between V line and V inverter. This has been drawn in as the vertical line, and for the conditions shown, just happens to be at 90° to the line voltage vector.

Now, it just so happens that the current in an inductor (in an AC circuit) always lags the applied voltage by 90°, so this means that they current in the inductor will flow back in line with the AC line voltage. Since the angle is between the line voltage and the inductor current, (which is the line current) is zero (ie exactly in line), the power factor is 1 (power factor = COS(0°) = 1).

The control system in **SineSaver** can manipulate the inverter output voltage, to be anywhere in the circled area. This means that the AC line current can be controlled to be any required magnitude and angle, so operation at any power factor is possible. This allows the line current to be reversed to provide

regenerative operation or set at 90° to the line voltage to give only reactive current. **SineSaver** can also do both of these at the same time, by automatically choosing a magnitude and angle for V inverter that results in the required level of energy transfer (in mathematical terms, the real current) and also the necessary reactive (imaginary) current to achieve the desired power factor.

In normal operation, **SineSaver** adjusts the real component of line current to always keep the DC bus voltage at a preset level by means of an inbuilt PID controller. The reactive current can be independently set by the user to the required value. In applications that just involve real power transfer between the AC and DC sides (in either direction), a unity power factor is desirable, so the reactive current reference is set to zero.

SINE SAVER Initial Start up

This procedure assumes that you have already installed and wired according to the instructions in the *Sine Saver Application Guide - IM00096* and that the various user adjustments are in the "factory default" state. See the "Sine Saver Operation" section of this manual for information on restoring factory default settings. Read the "Sine Saver Operation" section of this manual to become familiar with the way that various settings can be customized before you attempt to start up Sine Saver.

WARNING Hazardous voltages will be present during this procedure

This equipment must only be installed or adjusted by skilled personnel

1. Temporarily disconnect any wiring to the DC terminals of Sine Saver
2. Connect a voltmeter capable of safely reading the maximum DC voltage[1] to the DC terminals of Sine Saver.
3. Apply AC line power to Sine Saver and observe that the DC output voltage rises to approximately AC line voltage X 1.4
4. Start SineSaver by pressing the UP/RUN button. Observe that the DC voltage rises by about 10%. The exact value depends on the setting of the DC bus voltage.
5. Set the DC voltage to the required value. The default value will be suitable for the majority of applications. In the factory default state, Sine Saver uses R01 V PRESET 1 to determine the DC bus level. Edit this setting to change the DC bus voltage.
6. Other adjustments may be made according to the application. See application specific settings section below for suggested settings for various applications.
7. Once satisfactory DC voltage control has been achieved, other equipment may be connected to the DC terminals of SineSaver as required by the particular application.
8. **Ensure that the equipment connected to the DC side of Sine Saver includes an interlock so that it cannot run unless SineSaver is running. Relay RL1 on the control board may be used for this purpose. It should be configured for function O01 RUN (factory default setting). See page G04 RELAY1 on page 22 for additional information.**

[1] The maximum DC voltage is 400, 800 or 1050 for L (240VAC) , R (480VAC) and J (600VAC) models respectively. See specifications for additional detail.

Application specific settings

This section provides some basic notes that may be helpful in setting up Sine Saver for particular applications.

Ultra low harmonic rectifier for AC motor inverters or similar equipment

Line side converter for 4Q AC motor inverters

Choose a fixed DC voltage reference (this is the factory default setting)

Set DC voltage reference to be approximately 10% higher than the peak value of the highest expected AC line voltage. Eg, for a 460V AC supply with expected variation of +/-6%, use a value of 460 X 1.06 X 1.414 X 1.1 = 758 V. Note that typical AC drives that could be supplied with DC power by Sine Saver will have over voltage trip points around 800V, so the DC voltage must be set sufficiently below this value to allow for momentary DC bus voltage excursions caused by sudden load and / or speed changes on the AC drive.

Alternative energy systems

Energy recovery from DC systems (eg railways)

The considerations here are generally similar to those discussed above for 4 quadrant drive applications. There are additional issues to be considered in energy recovery systems where there may more than one source of DC supplied to the system, sometimes over a wide geographic area. In some instances a transformer may be required in the AC supply to Sine Saver, depending on the grounding arrangements on the DC system. The Line Voltage Compensated (LVC) references available in Sine Saver may be useful in overcoming recirculating energy problems in these systems.

Reactive power compensation - power factor COS(Ø) correction

Choose fixed DC bus reference at around 10% above the AC supply peak value (see 4 quadrant drive notes above). Selecting a DC voltage that is too low will degrade the AC line waveform quality

Set for external reactive current reference input (choose input type) and apply a suitable signal from an external reactive current measurement / controller device.

Line voltage stabilization for weak distribution lines (eg rural areas)

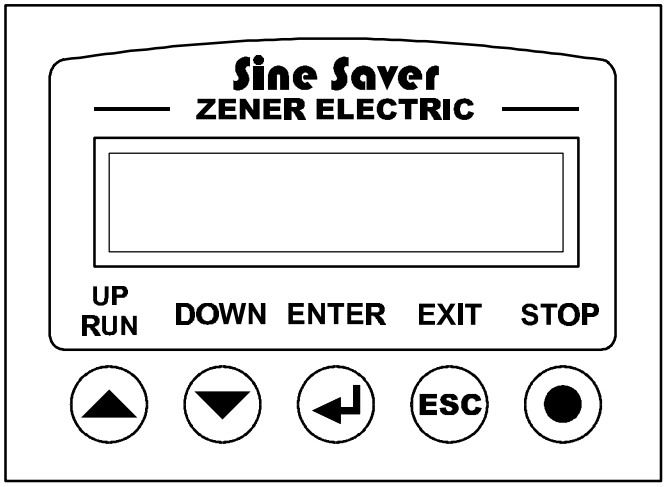
The same considerations as for reactive power compensation discussed above apply. The external reactive current reference should come from a controller that implements the user's chosen strategy for line voltage control.

SINE SAVER OPERATION

General operation

SINE SAVER has a structured arrangement of menus to allow custom settings for your particular application.

SINE SAVER is supplied with a link between the En terminal and the +5V terminal which is all that is required to run SINE SAVER from the console. A connection between these two terminals must always be made for the system to run.



The five pushbuttons and display form a console through which drive features and settings are altered to suit the application. When SINE SAVER is first powered up, the start banner is displayed for approximately 2 seconds. An example of the start banner is shown below. It displays the product configuration identification and the software version. While the banner is displayed the fan relay driver is switched on. It will then be turned off unless heatsink temperatures are high enough to require fan operation. This sequence will allow simple verification of fan operation.

Sine Saver R40
V1.02

SINE SAVER Run mode

Once the start banner is finished, Sine Saver is in the Run Mode. The top line contains the run variable. The second line contains the DC bus voltage and power factor reference values. Trip (error) messages are also displayed on this line. An example of the Run Mode display is shown below:

70	Amps AC
650 Vdc 40 A	

The example shows that the system is running with a line current of 70 Amps. The DC bus voltage is 650V and the reactive current reference is 40 Amps

Operation and access to the Run Mode and Menu Mode is done with the console push buttons. The action of each push button changes with the mode of operation and the state of the drive. The following table describes how the console push buttons affect the drive control.

Console Push Button operations

Console Mode	System Running	System Stopped
Menu mode Used for entering setup information.	• Pressing STOP will stop the system • Pressing ▲ or ▼ will either select another menu item or adjust a setting • Pressing ↵ will select the displayed menu item or accept the value being adjusted. • Pressing ESC will abort value adjustment or the current menu. If the current menu is the top of the menu tree, the console changes mode to the Run Display mode	• Pressing STOP will not reset trip conditions to allow trip messages to be viewed after exiting menu mode • Pressing ▲ or ▼ will either select another menu item or adjust a setting • Pressing ↵ will select the displayed menu item or accept the value being adjusted. • Pressing ESC will abort value adjustment or the current menu. If the current menu is the top of the menu tree, the console changes mode to the Run Display mode
Run Display mode	• Pressing STOP will stop the system • Pressing ▲ or ▼ will either increase or decrease the console reference value • Pressing ↵ will have no effect • Pressing ESC will abort the Run Display mode and the console changes to the Menu mode	• Pressing STOP will reset any trip condition • Pressing ▲ or ▼ will either increase or decrease the console reference value • Pressing ↵ will have no effect • Pressing ESC will abort the Run Display mode and the console changes to the Menu mode

Sine Saver Menu mode

The Menu mode is entered from the Run mode by pressing the ESC push button (pressing ESC again will return to Run mode). Use the ▲ and ▼ push buttons to display each menu item. To enter the menu press the ¿ push button. This action will either display another menu or display a setting ready for adjustment.

Control Console Menu

A00 DISPLAY

This menu allows selection of run variables. It also provides a "restore factory defaults" function.

A01 RUN VARIABLE

A single run variable is selected from this menu for display on the run screen.

V01 Amps	Line current magnitude
V02 Amps Real	Line current – in phase (real) component
V03 Amps Imag	Line current – reactive (imaginary) component
V04 Vac Line	Line voltage
V05 Vdc Bus	DC link voltage
V06 Vac Choke	Line inductor voltage
V07 kW	Line side power (real)
V08 kVAR	Line side reactive kVA
V09 kWh In	Line side total energy consumed from AC line
V10 kWh Out	Line side total energy returned to AC line
V11 Amps I^2t	Thermal overload level
V12 deg C T1	Power circuit temperature 1 °C
V13 deg C T2	Power circuit temperature 2 °C
V14 deg C T3	Power circuit temperature 3 °C
V15 deg C T4	Power circuit temperature 4 °C
V16 deg C T5	Power circuit temperature 5 °C
V17 deg C T6	Power circuit temperature 6 °C
V18 deg C T7	Power circuit temperature 7 °C
V19 deg C T8	Power circuit temperature 8 °C
V20 deg C HS	Temperature of the hottest power circuit temperature sensor that is included in the semiconductor virtual junction temperature °C
V21 deg C Tj	Semiconductor virtual junction temperature °C
V22 line Hz	Line frequency (Hz)
V23 pf	Line side power factor - COS(Ø)

A02 Menu Protect

The feature protects the entire menu mode with a code so that settings and configurations are protected from unauthorised changes. After you enable this feature, return to the Run Screen. The next time anyone presses ESC to enter the Menu mode the following message will appear:

A02 Enter Code 0

Use the ▲ and ▼ buttons to adjust the code value to the number **1470**. Press Enter to accept. If entered correctly, the familiar menu mode will be displayed. If the correct code is not entered you are returned back to the run screen. Note that protection code cannot be changed, so you can always gain access to the menus by reference to this manual.

A03 SET DEFAULTS

This menu allows the factory default parameters to be reinstalled. **SINE SAVER must be disabled before you can restore the defaults.** Pressing the Enter button will cause the message **A04 CONTINUE ?** to be displayed. This is intended as a warning and an opportunity to confirm that you want the factory default parameters installed.

Pressing the ENTER button again will cause the defaults to be loaded.

B00 AC LINE

This menu allows you to enter line inductor information. Press the Enter button to view and modify rated current and inductor value information.

B01 LINE VOLTS

Default value: system nominal line voltage

Range: 380 to 480 Volts AC (same as hardware voltage range).

Use the up or down push buttons to adjust this setting to nominal AC line voltage of the system. Press Enter when finished and the voltage is displayed or ESC to abort the adjustment.

B02 RATED AMPS

Default value: system nominal line current

Range: 25 to 150% of system nominal line current.

Use the up or down push buttons to adjust this setting to the line inductor continuous rated current in amps. Press Enter when finished and the current is displayed or ESC to abort the adjustment.

Entering the rated current of your line inductor determines the operation points for the I^2t feature. This setting is not used to limit the output current of Sine Saver. Refer to D01 CURRENT LIMIT for that particular feature.

B03 RATED FREQ

Default value: 50Hz

Range: 48 to 62 Hz

Use the up or down push buttons to adjust this setting to the line frequency. Press Enter when finished and the frequency is displayed or ESC to abort the adjustment.

B04 % IMPEDANCE

Default value: 15%
Range: 2 - 25%

Use the up or down push buttons to adjust this setting to the line inductor impedance. Press Enter when finished or ESC to abort the adjustment. % impedance is defined as the percentage of the system phase voltage (ie phase to neutral voltage) that is dropped across the line inductor at the system nominal line current.

C00 PERFORMANCE

This section allows you to set the system performance characteristics.

C01 CARRIER FREQ

Available Choices: C02 4kHz (default)
C03 8kHz

This value sets the switching frequency that the system uses to control the line currents. This frequency is noticeable as a ripple on the line current waveform and also an audible sound from the line inductor. Higher settings reduce the ripple on the line current waveform resulting in a lower level of distortion. Semiconductor switching losses will increase with switching frequency. For most efficient operation select 4 kHz. Press Enter then use the up or down buttons to choose the CARRIER FREQ. Press Enter when finished to accept the choice or ESC to abort.

C04 BUS P.I.D.

C05 BUS PB%
Default value: 15%
Range: 10% to 1000%

C06 BUS Ti sec/r
Default value: 0.10
Range: 0 to 20.0

C07 BUS Td secs
Default value: 2.00
Range: 0 to 4

C08 Reactive P.I.D.

C09 React PB%
Default value: 300%
Range: 10% to 1000%

C10 React Ti sec/r
Default value: 2.00
Range: 0 to 20.0

C11 BUS Td secs
Default value: 0.00

Range: 0 to 4

C12 Delay

Default value: 1.00

Range: 0 to 3

C4…11 set the tuning parameters of the internal PID controllers that regulate the DC link voltage and the reactive current. C12 Delay provides a means of compensating for small phase shifts in the AC line voltage reference that may occur, for example, if a potential transformer is used. C12 is in milliseconds.

Use the ▲ and ▼ push buttons to adjust the value and press Enter to accept the value or ESC to abandon changes. **Do not adjust these parameters without prior consultation with the factory.**

D00 PROTECTION

This section lets you set the system thermal protection features.

D01 CURRENT LIM

Default value: System overload current.

Range: 25 to 100% of System Overload Current.

This sets the maximum line current of Sine Saver.

Press Enter then use the up or down buttons to adjust the CURRENT LIM. Press Enter when finished to accept the adjustment or ESC to abort.

D02 I^2t

The I^2t feature estimates the heating of the line inductor according to the line current. When the estimated heating exceeds I^2t setting, the drive will trip on I^2t. For a system running at 110% of its I^2t current this will take approximately two minutes. The time to trip will shorten the further the line current exceeds the I^2t value.

If power is removed from the drive after an I^2t trip, the system should be allowed to cool down before it is restarted. Direct sensing devices such as microtherms or thermistors may be fitted to the line inductor or other power components (eg transformers) for additional protection

D02 I^2t

Default value: system nominal current

Range: 25% to 100% of system Overload Current listed, entered in amps.

This sets the upper limit of I^2t and is entered in amps. This is equivalent to the usual I^2t setting. Use the ▲ and ▼ push buttons to adjust the D02 I2t value and press Enter to accept the value or ESC to abandon changes.

E00 STOP/RUN

This section sets the system stopping and starting modes.

E01 AUTO RESTART

Auto Restart allows Sine Saver to automatically attempt to restart after a trip occurs. If Sine Saver trips it will wait 10 seconds then attempt to clear the fault. If it is unsuccessful it will keep trying every ten seconds. It will do this the number of times specified in A/Rs ALLOWED. If the fault is cleared and the drive runs without tripping for the A/R CLR TIME the number of auto restarts attempted will start counting from 1 again. If the trip is cleared by any other means the fault count will start from 1 again.

E02 A/Rs ALLOWED

Default value: 0
Range: 0 to 15 restarts

This number indicates how many times SINE SAVER will attempt to restart after a trip. For the system to run after the trip is cleared, the drive must be given a valid run command. Select 0 restarts in order to de-activate Auto Restart.

Use the up or down buttons to adjust A/Rs ALLOWED. Press Enter to accept the adjustment or ESC to abort.

E03 A/R CLR TIME

Default value: 20 min
Range: 0.1 to 20 min

If SINE SAVER operates for the A/R CLR TIME without any trips occurring the number of restarts is reset to the value of A/Rs ALLOWED. Set the A/R CLR TIME to 0.1min for infinite auto restarts.

Use the up or down buttons to adjust A/R CLR TIME. Press Enter to accept the adjustment or ESC to abort.

E04 Reset by PF

Available Choices: H00 ENABLE
H01 DISABLE (default)

Enabling this facility allows SINE SAVER to reset all trips when a momentary power failure occurs. This feature is useful in power-up start applications because trips may be cleared without any extra switch logic by turning the power off and straight back on again without waiting for the system to completely power down.

Use the up or down buttons to select either Enable or Disable. Press Enter to accept the selection or ESC to abort.

F00 REFERENCES

This lets you set the voltage and current references for the different SINE SAVER operating modes.

F01 BUS LEVEL

Available Choices: R01 V PRESET 1 (default)
R02 V PRESET 2
R03 V PRESET 3
R04 V PRESET 4
R05 V PRESET 5
R06 LVC PRESET 1
R07 LVC PRESET 2
R08 LVC PRESET 3
R09 SELECTOR

This reference is the set point used by the DC bus voltage control function of Sine Saver. The DC bus voltage control is active whenever Sine Saver is running.

F02 REACTIVE CUR

Available Choices:
R09 SELECTOR
R10 Li PRESET 1
R11 Li PRESET 2
R12 Li PRESET 3
R13 Li PRESET 4
R14 Reserved for future use as PF PRESET
R15 ZERO (default)
R16 AN1
R17 CONSOLE

The reference source selected here determines how the reactive component of the line current is controlled. In many applications, the reactive current is undesirable and the default choice of Zero is used. Use the ▲ and ▼ push buttons to select a reference and press Enter to accept the selection or ESC to abandon.

Reference list

R00 AN1

When the Analog Input is selected as a reference for any of the different operating modes, two parameters need to be checked. SINE SAVER will let you do this every time the analog input is selected as a reference. They are **R01 REF AT 0%** and **R02 REF AT 100%**. Use the up or down buttons to change the values (if required). Press enter to accept the value or ESC to abort.

R18 INPUT CONFIG

R18 INPUT CONFIG

Available choices:
R19 0-10V [00]
R20 0-5V [01] (default)
R21 4-20mA [11]

This selection allows different signal ranges to be accommodated. The values in brackets (eg [00]) serve a reminder to set the switches on the control board to appropriate positions.

R22 AMPS @ LO IN

Default value: 0%
Range: - 100% to 100%

This value specifies the reactive current reference value when the minimum input signal is present at the analog input terminals. See R25 and R27 to set the maximum value of input signal to be used.

R23 AMPS @ HI IN

Default value: 0%
Range: 0% to 100%

This value specifies the reactive current reference value when the maximum input signal is present at the analog input terminals. See R24 and R26 to set the minimum value of input signal to be used.

R24 LO INPUT V

Default value:

Range:

This value specifies the minimum value of the input signal range to be used with the analog input terminals. For example, if the signal range is 3 to 10 volts, select the 0-10V range (R18 INPUT CONFIG / R19 0-10V) and then set R24 LO INPUT V to 3 volts. This adjustment is only used when an analog input voltage range is selected. Use R26 LO INPUT mA for the 4 - 20mA input range.

R25 HI INPUT V

Default value:

Range:

This value specifies the maximum value of the input signal range to be used with the analog input terminals. For example, if the signal range is 0 to 9 volts, select the 0-10V range (R18 INPUT CONFIG / R19 0-10V) and then set R25 HI INPUT V to 9 volts. This adjustment is only used when an analog input voltage range is selected. Use R27 HI INPUT mA for the 4 - 20mA input range.

R26 LO INPUT mA

Default value:

Range:

This value specifies the minimum value of the input signal range to be used with the analog input terminals. For example, if the signal range is 8 to 20 mA, select the 4-20 mA range (R18 INPUT CONFIG / R21 4 - 20mA) and then set R26 LO INPUT mA to 8 mA. This adjustment is only used when the analog input 4-20 mA range is selected. Use R24 LO INPUT V for the voltage ranges.

R27 HI INPUT mA

Default value:

Range:

This value specifies the maximum value of the input signal range to be used with the analog input terminals. For example, if the signal range is 4 to 12 mA, select the 4-20 mA range (R18 INPUT CONFIG / R21 4 - 20mA) and then set R26 HI INPUT mA to 12 mA. This adjustment is only used when the analog input 4-20 mA range is selected. Use R25 HI INPUT V for the voltage ranges.

R17 CONSOLE

When this is selected, the reference is set from the console using the ▲ and ▼ arrows when SINE SAVER is in the run mode.

R01 V PRESET 1

R02 V PRESET 2

R03 V PRESET 3

R04 V PRESET 4

R05 V PRESET 5

Default values: 155, 0, 0, 0, 0% respectively

Range: 0% to 200%

These presets provide extra reference values for the DC link. When a preset is selected, it is adjusted using the console ▲ and ▼ push buttons. Presets 2, 3, 4 and 5 are used in conjunction with the reference selector.

R06 LVC PRESET 1

R07 LVC PRESET 2

R08 LVC PRESET 3

Default value: 109%

Range: 105% to 137%

These presets are DC link voltage reference values with the special property that they are compensated with respect to line voltage at the time of use. The effective value of line voltage compensated (LVC) presets is:

Set value X measured RMS line voltage X 1.414

LVC presets are intended to be used as DC bus level reference values in applications where it is desirable that the DC bus voltage reference tracks the line voltage in order to avoid circulation of energy when uncontrolled rectifiers feed the same DC bus.

When an LVC preset is selected, it is adjusted using the console ▲ and ▼ push buttons. LVC presets 2 and 3 are used in conjunction with the reference selector.

R10 Li PRESET 1

R11 Li PRESET 2

R12 Li PRESET 3

R13 Li PRESET 4

Default values: 155, 0, 0, 0, 0% respectively

Range: 0% to 200%

These presets provide extra reference values for reactive current. When a preset is selected, it is adjusted using the console ▲ and ▼ push buttons. These presets can also be used in conjunction with the selector.

R14 Reserved for future use

R15 ZERO

Default value: 0%
Range: Not adjustable

This is simply the value 0%. Typically it will be used as the reactive current reference in applications that do not involve reactive current control.

Note: It is also possible to generate zero from the reference selector, both methods produce the same result.

SELECTOR

R09 SELECTOR

This feature allows the actual reference used to be selected from one of eight possible sources according digital inputs on the terminal strip. It is a convenient way to allow external digital signals to determine the source of the reference to be used. The references available depend on whether the selector is used for the DC link voltage or the reactive current reference.

Selector used for the DC link voltage reference

Reference	Terminal D2	Terminal D3	Terminal D4
R01 V PRESET 1	Low	Low	Low
R02 V PRESET 2	Low	Low	High
R03 V PRESET 3	Low	High	Low
R04 V PRESET 4	Low	High	High
R05 V PRESET 5	High	Low	Low
R06 LVC PRESET 1	High	Low	High
R07 LVC PRESET 2	High	High	Low
R08 LVC PRESET 3	High	High	High

Selector used for the reactive current reference

Reference	Terminal D2	Terminal D3	Terminal D4
R10 Li PRESET 1	Low	Low	Low
R11 Li PRESET 2	Low	Low	High
R12 Li PRESET 3	Low	High	Low
R13 Li PRESET 4	Low	High	High
R14 PF PRESET[2]	High	Low	Low
R15 ZERO	High	Low	High
R16 AN1	High	High	Low
R17 CONSOLE	High	High	High

[2] R14 is reserved for future use as PF PRESET. It has no function in the current software version.

G00 INPUT/OUTPUT

G01 RUN COMMAND

Available choices: G02 ENABLE
G03 CONSOLE PB (default)

This selection allows source of the run command to be selected.

Selecting G02 ENABLE will cause SINE SAVER to run whenever the enable terminal is connected to +5V. The UP/RUN and STOP console buttons will be ignored.

G03 CONSOLE PB will only allow SINE SAVER to run if enable terminal is connected to +5V and the UP/RUN console button is pressed. Pressing the STOP console button or removing +5V from the enable terminal will cause the system to stop.

G02 is the usual selection for a normal installation. G03 CONSOLE PB may be convenient for commissioning and adjusting the system.

G04 RELAY1

G05 RELAY2

These two menu items permit an individual function assignment to each relay output. Pressing enter on these menu items presents a list of output functions with the currently assigned function being presented first.

Some relay functions require a value to be set. When these functions are selected the chance to set the value will follow with the current value displayed first.

Use the ▲ and ▼ push buttons to move through the list, press Enter to select the new function or Esc to abort.

Relay Output Functions

Function	Indication when energised	Parameters
O01 RUN	Indicates that the system is running.	none
O02 TRIP	Indicates the presence of a trip that has stopped the system.	none
O03 ON	Relay is continuously energised as long as power is available.	none
O04 OFF	Relay is de-energised.	none
OO5 A/R FAIL	Indicates that the drive could not auto restart as all restarts have been exhausted.	none
OO6 I2t TRIP	Indicates that the I^2t overload feature has activated.	none
OO7 OVER TEMP	Indicates that power components are too hot for safe operation.	none

Display Messages

SINE SAVER displays a variety of messages on the second line of its display to indicate the drive status. These messages may be divided into two types, trip messages and run messages.

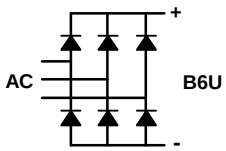
SINE SAVER will protect the power components under a variety of fault conditions. When one of these conditions is experienced SINE SAVER will trip, shut down the line current output and display one of the following messages. The message will be displayed until the fault is cleared and a reset signal is applied. The reset signal may take the form of a 5V pulse applied to the control board reset terminal (D1), pressing the stop button manually or operation of the power fail reset or auto restart functions.

Trip Message	Meaning
OUTPUT SHORT	The power semiconductor protection has stopped the system.
HOT DEVICES	The calculated virtual junction temperature of a power semiconductor has exceeded the maximum permitted temperature.
CHARGE RLY OPEN	There is no feedback signal to confirm that the slow charge contactor is closed.
OVER VOLTAGE	The DC Bus voltage has exceeded its maximum value.
OVER CURRENT	SINE SAVER control system has detected an excessive line current value.
LOW BUS VOLTS	The DC Bus voltage has fallen below its minimum threshold.
POWER FAILURE	All input phases on the input power supply are either low or missing.
HOT HEATSINK	One or more temperature sensors in the power semiconductor section is too hot.
I2T TRIP	An I^2t trip has occurred.
UNKNOWN PWR BRD!	The SineSaver software does not recognise the power board or the power interface board as a invalid type.

The following messages indicate the current operating condition of SINE SAVER.

Run Message	Meaning
CHARGING	SINE SAVER is waiting for the DC Bus capacitors to be fully charged.
CURRENT LIMIT	The line current is at the maximum overload point.
NOT ENABLED	SINE SAVER is ON but has no enable signal.
RUNNING	SINE SAVER is operating normally.

Definitions

Term	Definition
Line voltage	The voltage between two phase conductors (in a 3 phase system)
Phase voltage	The voltage between one phase conductor and the neutral conductor (even if the neutral conductor does not physically exist).
Nominal line voltage	The value of AC line voltage used for design purposes.
Rated current	The maximum value of current that can be sustained indefinitely.
Overload current	A current value exceeding the rated current. Only permitted for a limited time.
Line voltage compensated (LVC)	A reference value that automatically follows the ratio (Actual AC line voltage) / (Nominal AC line voltage).
B6U	An uncontrolled, 3 phase rectifier configuration defined in IEC 60146 
Type I coordination Type II coordination	According to IEC 60947.4.1 (also AS/NZS 3947.4.1:2001) : Low-voltage switchgear and controlgear - Contactors and motor-starters - Electromechanical contactors and motor-starters Type "1" coordination requires that, under short circuit conditions, the contactor or starter shall cause no danger to persons or installation **and may not be suitable for further service without repair and replacement of parts**. Type "2" coordination requires that, under short circuit conditions, the contactor or starter shall cause no danger to persons or installation **and shall be suitable for further use**
SKiiP	Semikron Integrated Intelligent Power Module – see www.semikrom.com for further information
Power stack	An assembly of power semiconductors (typically IGBTs, diodes) together with heatsinks, DC link capacitors etc.
Switchgear	A general term covering power switches, contactors, fuse circuit breakers etc. Usually applied to power components rather than control circuit elements.
PU	A measurement system in which all values are stated in terms of their magnitude relative to the nominal value of the quantity.
PU impedance base	The nominal impedance value used for PU impedances. Generally (nominal phase voltage) / (rated current)
Line reactor	An inductor connected in series with the AC line for the purposes of increasing the AC line impedance seen by the equipment.
SMPS	Switch Model power Supply
I^2t	A protection function that simulates the heating effect of current in a conductor.
Class I circuit	Any wiring or components that are not in a class II circuit. Typically this will be wiring or components at a hazardous voltage / current connected to the AC line or DC link.
Class II circuit	Wiring or components that are in a low voltage, low energy circuit that meets certain requirements for voltage / current levels and segregation from class I circuits.

SINE SAVER Trouble Shooting Guide

Symptom	Cause	Remedy
LCD backlight does not illuminate.	Input power wiring not connected properly.	Check input power wiring, refer to SINE SAVER Electrical Installation Diagram.
	Input voltage not within specification.	Measure the input voltage at SINE SAVER input terminals. Check with specifications.
	No 24VDC supply	Check output of SMPS
No line current.	Enable signal is not active.	Check that the EN terminal is connected to +5V Check that the ENABLED message is displayed.
V LIMIT message appears continuously.	Input voltage has exceeded maximum rating.	See SINE SAVER General Specifications for input voltage ratings.
OPT SC message appears	Hardware level protection in power stack activated.	Check power components
OC	Line current was greater than SINE SAVER's maximum current.	Check system current ratings.
OV message appears.	Input voltage has exceeded maximum ratings.	See general specification and check the input is within ratings.
		Check input supply for voltage transients. Fix the external source.
OT message.	Ventilation problem.	Ensure operating ambient temperature is within specification.
		Check fans are rotating freely and there is no build up of dust or debris in blades.
		Visually examine the heatsink fins for build up of dust and debris.
	System is constantly overloaded.	Check SINE SAVER continuous current and ambient temperature rating.

Your SINE SAVER Setup Notes

Photocopy this page or complete in pencil

User Parameters **Date.....**

A00 DISPLAY	User	Default	R00 AN1	User	Default
A01 RUN VARIABLE		V01 Amps	R18 INPUT CONFIG		R20 0-5V [01]
A02 MENU PROTECT		Disabled	R22 AMPS @ LO IN		
B00 AC LINE			R23 AMPS @ HI IN		
B01 LINE VOLTS			R24 LO INPUT V		
B02 RATED AMPS			R25 HI INPUT V		
B03 RATED FREQ			R26 LO INPUT mA		
B04 % IMPEDANCE			R27 HI INPUT mA		
C00 PERFORMANCE			R01 V PRESET 1		
C01 CARRIER FREQ	8KHz	4KHz	R02 V PRESET 2		
C05 BUS PB%	10%	15%	R03 V PRESET 3		
C06 BUS Ti sec/r	1.00	0.1	R04 V PRESET 4		
C07 Bus Td secs	1.00	2.00	R05 V PRESET 5		
C09 React PB%	100%	300%	R06 LVC PRESET 1		
C10 React Ti sec/r	1.00	2.00	R07 LVC PRESET 2		
C11 React Td secs	0.00	0.00	R08 LVC PRESET 3		
C12 Delay		1.00	R10 Li PRESET 1		
D00 PROTECTION			R11 Li PRESET 2		
D01 CURRENT LIM			R12 Li PRESET 3		
D02 I^2t			R13 Li PRESET 4		
E00 STOP/RUN			R14 PF PRESET		
E01 AUTO RESTART			**G00 INPUT/OUTPUT**		
E02 A/Rs ALLOWED			G01 RUN COMMAND		
E03 A/R CLR TIME			G04 RELAY 1		
E04 Reset by PF			G05 RELAY 2		
F00 REFERENCES					
F01 BUS LEVEL		R01 V PRESET			
F02 REACTIVE CUR		R15 ZERO			

SINE SAVER Specifications

AC Line Voltage

R	380 to 480Vac, 3Ø
J	440 to 600Vac, 3Ø
L	208 to 240Vac, 3Ø

All these voltages have a tolerance of –15% to +10%

Line Frequency

48 to 62Hz

DC Over Voltage Trip

R	808VDC
J	1050VDC
L	400VDC

Environmental

Storage Temperature:
-20 to +70º C -4 to 158º F
Operating Temperature:
0 to 50º C 32 to 122º C
Relative Humidity: 5 to 95%
Non condensing
Altitude: 0 to 1000m
0 to 3281 feet

Standards Compliance

Segregation between Class I and Class II circuits and clearance / creepage distances designed to meet the requirements of UL 508C

Local Controls

Up/Run, Down, Enter, Exit, Stop

Terminal Strip

Digital Inputs
- +5V and DIG COM
  - 5Vdc supply,
  - 40mA max current
- D1 to D4 and EN Digital Inputs
  - Logic High 3 to 5Vdc
  - Logic Low 0 to 2Vdc

Analog Input
- Vref and AN COM
  - +5Vdc Supply
  - 5mA max current
- IN+ and IN-
  - Differential Input
  - 0 to 5V range
  - 0 to 10V range
  - 0 to 20mA range
  - 4 to 20mA range
- Common mode range
  - ± 25Vdc to AN COM

Relay Outputs
- 2 Form C Outputs (Single pole change over contacts)
- Contact Rating (Resistive load)
  - 5A@250Vac
  - 5A@30Vdc
- Contact Rating (Inductive load)
  - 2A@ 250Vac
  - 2A@30Vdc

User Parameters

Switching Frequency 4 or 8kHz, user selectable

Current Limit
20 to 100% of max overload current

I^2t 20 to 110% of max cont current

Auto Restart
Number of restarts
0 to 20
Reset time:
0.1 to 20 minutes

References
Analog Input
Console Reference
Presets
Line compensated presets
Digitally controlled reference selector

The following functions can be enabled or disabled:

Menu Protect

Reset by Power Failure

Automatic Restart

Protection

Power stack IGBT protection is provided by the driver circuit electronics (typically Semikron SKiiP modules) and the trip status is displayed by Sine Saver.

Note that the line side converter topology used in a Sine Saver system requires semiconductor fuses to properly protect the diodes and other power components in the power stack

It is essential that appropriately selected semiconductor fuses are used.

The Sine Saver Control Package Application Guide - IM00096 contains details of the fuse selection criteria.

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